

TITLE OF THE INVENTION

STOCKER, EXPOSURE APPARATUS, DEVICE MANUFACTURING
METHOD, SEMICONDUCTOR MANUFACTURING FACTORY, AND
EXPOSURE APPARATUS MAINTENANCE METHOD

5

FIELD OF THE INVENTION

The present invention relates to a stocker for
stocking an object to be stocked such as a reticle or
wafer in a semiconductor manufacturing process, an
10 exposure apparatus having the stocker, a device
manufacturing method, a semiconductor manufacturing
factory, and an exposure apparatus maintenance method
and, more particularly, to a stocker for an object to be
stocked in an exposure apparatus using an F₂ excimer
15 laser as an exposure light source.

BACKGROUND OF THE INVENTION

In recent years, the wavelength of an exposure
light source used in an exposure apparatus is becoming
20 much shorter in the manufacture of a semiconductor
device. A short wavelength increases the resolution of a
projection exposure system concerning exposure, which
enables exposure of a finer pattern. An F₂ excimer laser
has a wavelength as short as 157 nm, and is being
25 applied to an exposure apparatus. The wavelength of 157
nm falls within a wavelength region generally called a
vacuum ultraviolet region. In this wavelength region,

light is greatly absorbed by oxygen molecules and hardly passes through outer air. Thus, the F₂ excimer laser can be applied in only an environment where the atmospheric pressure is decreased to almost vacuum and the oxygen concentration is sufficiently decreased. According to a reference "Photochemistry of Small Molecules" (Hideo Okabe, A Wiley-Interscience Publication, 1978, p. 178), the absorption coefficient of oxygen with respect to light having a wavelength of 157 nm is about 190 atm⁻¹cm⁻¹. This means that a transmittance T per cm is only $T = \exp(-190 \times 1 \text{ cm} \times 0.01 \text{ atm}) = 0.150$ when light having a wavelength of 157 nm passes through gas having an oxygen concentration of 1% at 1 atmospheric pressure.

Japanese Patent Publication 5-66733 discloses an interface apparatus for an integrated circuit. This apparatus relates to a box for storing integrated circuit wafers and an interface for the wafers in the box. This prior-art invention also discloses exchange of wafers so as to inhibit entrance of a foreign matter such as dust.

In an exposure apparatus using an F₂ excimer laser, absorption by oxygen at a wavelength of 157 nm is conspicuous. To obtain a satisfactory transmittance, the oxygen concentration must be reduced to 1 ppm or less, and the concentration must be strictly controlled. Members which are frequently loaded/unloaded into/from the exposure apparatus are wafers and reticles

(including masks), which are usually stocked in a clean room or the like. The oxygen concentration cannot be satisfactorily reduced even by arranging a mechanism for reducing oxygen in transporting a wafer or reticle to the exposure apparatus. Such a mechanism becomes an oxygen mixing source into the exposure apparatus, and decreases the yield of the exposure apparatus.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above situation, and has as its object to stock a reticle or wafer in an atmosphere where the oxygen concentration is reduced to about 5 ppm before the reticle or wafer is transferred to an exposure apparatus.

It is another object of the present invention to transport a reticle or wafer in an oxygen-concentration-reduced atmosphere to an exposure apparatus without exposing the reticle or wafer to outer air.

To achieve the above objects, according to the present invention, a stocker for stocking an object to be stocked such as a reticle, mask, or wafer has the following arrangement.

According to the first arrangement, a stocker comprises a first sealing member, atmosphere control means for controlling an internal atmosphere of the

first sealing member to a first atmosphere, and transfer means for transporting an object to be stocked to an exposure apparatus or receiving the object to be stocked from the exposure apparatus without exposing the objects to be stocked to an external atmosphere of the first sealing member, wherein at least one object to be stocked is stocked in the first sealing member.

According to the second arrangement, a stocker comprises a first sealing member, first atmosphere control means for controlling an internal atmosphere of the first sealing member to a first atmosphere, a second sealing member for storing at least one object to be stocked, second atmosphere control means for controlling an internal atmosphere of the second sealing member to a second atmosphere, and transfer means for transporting the object to be stocked to an exposure apparatus or receiving the object to be stocked from the exposure apparatus while the object to be stocked is stored in the second sealing member without being exposed to an external atmosphere of the first sealing member, wherein at least one second sealing member which stores at least one object to be stocked is stocked in the first sealing member.

The stocker of the present invention may further comprise a load-lock chamber. In this case, the object to be stocked is transported to the outside of the first sealing member or received from the outside of the first

sealing member via the load-lock chamber. At this time,
the object to be stocked is preferably transported to
the outside of the first sealing member or received from
the outside of the first sealing member while stored in
5 the second sealing member.

The stocker may further comprise atmosphere
measurement means such as oxygen analyzers for measuring
the internal atmospheres of the first sealing member
and/or the second sealing member. In the first
10 arrangement, it is desirable that the first atmosphere
have an oxygen concentration of 50 ppm or less. In the
second arrangement, it is desirable that the first
atmosphere have an oxygen concentration of 50 ppm or
less and the second atmosphere have an oxygen
15 concentration of 5 ppm or less. In either case, the
first and second atmospheres are usually an inert gas
atmosphere, and preferably a nitrogen gas atmosphere, a
helium gas atmosphere, or a gas mixture atmosphere of
nitrogen gas and helium gas. For this purpose, the
20 atmosphere control means preferably has gas injection
means for injecting inert gas or the like, or evacuation
means for discharging gas from the stocker.

The stocker of the present invention is desirably
connected to the exposure apparatus via a highly
25 airtight transfer path, and is suitable for an exposure
apparatus using an F₂ excimer laser as an exposure light
source.

For example, transfer means for transporting the object to be stocked to manufacturing apparatuses for various processes or receiving the object to be stocked from the manufacturing apparatuses for various processes is desirably arranged in a semiconductor manufacturing line.

In a reticle or mask stocker, a desired one of stocked reticles or masks is supplied to the exposure apparatus by, e.g., a reticle changer.

With this arrangement, the object to be stocked can be transported to the exposure apparatus without being exposed to outer air while the oxygen concentration in the stocker is maintained at 50 ppm or less and especially the oxygen concentration around the substrate such as a reticle or wafer is maintained at about 5 ppm. The oxygen concentration can be quickly reduced to 1 ppm or less by loading the object to be stocked into the exposure apparatus via, e.g., the load-lock chamber. The evacuation means is adopted to repeat discharge and gas injection, which can reduce the oxygen concentration to about 5 ppm faster than the case of only gas injection. Particularly in an exposure apparatus using an F_2 excimer laser as a light source, a high-quality semiconductor device can be manufactured while absorption of a laser beam is reduced and the yield is kept high.

An exposure apparatus of the present invention for

transferring a pattern drawn on a reticle or mask to a wafer by exposure comprises a stocker having the above features in order to stock substrates such as reticles, masks, or wafers.

5 The exposure apparatus of the present invention further comprises a display, a network interface, and a computer for executing network access software. This enables communicating maintenance information of the exposure apparatus via a computer network. The network
10 software is connected to an external network of a factory where the exposure apparatus is installed, provides on the display a user interface for accessing a maintenance database provided by a vendor or user of the exposure apparatus, and enables obtaining information
15 from the database via the external network.

 A device manufacturing method of the present invention comprises the steps of installing manufacturing apparatuses for various processes including an exposure apparatus in a semiconductor
20 manufacturing factory, and manufacturing a semiconductor device in a plurality of processes by using the manufacturing apparatuses. The device manufacturing method may further comprise the steps of connecting the manufacturing apparatuses by a local area network, and
25 communicating information about at least one of the manufacturing apparatuses between the local area network and an external network of the semiconductor

manufacturing factory. It may also be possible that maintenance information of the manufacturing apparatus is acquired by data communication by accessing via the external network a database provided by a vendor or user of the exposure apparatus, or production is managed by data communication via the external network with a semiconductor manufacturing factory other than the semiconductor manufacturing factory.

A semiconductor manufacturing factory of the present invention comprises manufacturing apparatuses for various processes including the exposure apparatus of the present invention, a local area network for connecting the manufacturing apparatuses, and a gateway for allowing the local area network to access an external network of the factory, wherein information about at least one of the manufacturing apparatuses is communicated.

A maintenance method for the exposure apparatus of the present invention comprises the steps of causing a vendor or user of the exposure apparatus to provide a maintenance database connected to an external network of the semiconductor manufacturing factory, authenticating access from the semiconductor manufacturing factory to the maintenance database via the external network, and transmitting maintenance information accumulated in the maintenance database to the semiconductor manufacturing factory via the external network.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate
5 the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a stocker according to the first embodiment of the present
10 invention;

Fig. 2 is a block diagram showing a stocker according to the 12th embodiment of the present invention;

Fig. 3 is a block diagram showing a stocker according to the second embodiment of the present
15 invention;

Fig. 4 is a block diagram showing a stocker according to the fourth embodiment of the present invention;

Fig. 5 is a block diagram showing a stocker according to the eighth embodiment of the present
20 invention;

Fig. 6 is a view showing the concept of a semiconductor device production system when viewed from
25 a given angle;

Fig. 7 is a view showing the concept of the semiconductor device production system when viewed from

another angle;

Fig. 8 is a view showing an example of a user interface;

Fig. 9 is a flow chart for explaining the flow of
5 a device manufacturing process; and

Fig. 10 is a flow chart for explaining a wafer process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 Preferred embodiments of the present invention will be described.

[First Embodiment]

Fig. 1 shows a reticle stocker according to the first embodiment of the present invention. In Fig. 1,
15 reference numeral 11 denotes a load-lock chamber; 12, a reticle stocker; 13, an oxygen analyzer; 14, a nitrogen injection port; and 15, a discharge port. In the first embodiment, nitrogen is injected from the nitrogen injection port at a desired flow rate. The discharge
20 port 15 may be kept open. The flow rate of injected nitrogen is controlled to keep the interior of the reticle stocker 12 at a higher positive pressure than the outside. The flow rate is controlled in accordance with the internal oxygen concentration. When the oxygen
25 concentration after release to outer air is high, nitrogen equal to the volume of the reticle stocker 12 is supplied, and after the oxygen concentration is

reduced to about 5 ppm, the flow rate is decreased. It may also be possible to increase the airtightness of all the injection port 14, discharge port 15, and reticle stocker 12 and to maintain the inside at a lower

5 pressure than the atmospheric pressure. The oxygen analyzer 13 always monitors the oxygen concentration in the reticle stocker 12. If the oxygen analyzer 13 detects an oxygen concentration of 5 ppm or more, the nitrogen flow rate is controlled to be increased so as
10 to reduce the concentration again. An exposure apparatus (not shown) comprises the load-lock chamber 11, and exchanges a reticle or wafer via the load-lock chamber 11 so as to inhibit mixture of oxygen or any impurity into the exposure apparatus. To reduce oxygen in the
15 exposure apparatus to 1 ppm or less by one passage through the load-lock chamber 11, the oxygen concentration is preferably reduced to 5 ppm or less in the stocker on the preceding stage. Depending on the performance of the load-lock chamber 11, the oxygen
20 concentration can be reduced to 1 ppm or less by atmosphere replacement before the exposure apparatus even if an oxygen concentration of about 10 ppm is permitted in the stocker.

As a criterion of reducing the nitrogen flow rate
25 and oxygen concentration, injection of nitrogen at 6 L/min into a reticle stocker having a volume of 30 L decreases the oxygen concentration to about 5 ppm within

about 2 h from a state wherein the reticle stocker contains normal outer air. The reticle stocker maintains this oxygen concentration by continuously supplying nitrogen. The oxygen concentration can be reduced within
5 a shorter time by supplying a larger amount of nitrogen.

The stocking forms of the reticle stocker include stocking only a reticle, a reticle cassette for storing one reticle, and a reticle box for storing a plurality of reticle cassettes. The reticle cassette and box are
10 designed with higher airtightness than that of a conventional reticle cassette and box for shielding a foreign matter such as dust, and will be referred to as a highly airtight reticle cassette and box hereinafter.

A reticle is loaded into the reticle stocker 12
15 via the load-lock chamber 11 together with the highly airtight reticle cassette or box or by only itself. The load-lock chamber 11 basically enables loading the reticle into the reticle stocker 12 while preventing an increase in oxygen concentration. In practice, oxygen at
20 ppm level is mixed because it is difficult to remove oxygen left at the reticle itself or the fine structure of the highly airtight reticle cassette or box. For this reason, the oxygen concentration of the reticle stocker 12 increases at ppm level temporarily or gradually after
25 receiving the reticle. However, the residual oxygen diffuses with the lapse of time during stocking and is diluted by the flow of nitrogen, thus reducing the

oxygen concentration again.

The highly airtight reticle cassette or box is opened to replace the internal atmosphere by nitrogen in passing through the load-lock chamber 11. To remove the residual oxygen by diffusion, the highly airtight reticle cassette or box is also opened in the reticle stocker 12.

In the use of a reticle, whether the reticle can be used is determined by confirming the oxygen concentration or whether the reticle has been stocked in the reticle stocker 12 for a predetermined time. A reticle stocked without any cassette or box is stored and tightly sealed in the highly airtight reticle cassette or box in the reticle stocker 12. A reticle stocked and stored in the highly airtight reticle cassette or box is in an open state and thus is tightly sealed. The tightly sealed reticle is passed through the load-lock chamber 11, and extracted from the reticle stocker 12 while the interior of the highly airtight reticle cassette or box is maintained in a nitrogen atmosphere where the oxygen concentration is low. The highly airtight reticle cassette or box is loaded via the load-lock chamber 11 of the exposure apparatus. As a result, the reticle can be used while the atmosphere around the reticle is kept at a low oxygen concentration, and the efficiency and yield of the exposure apparatus can be increased.

[Second Embodiment]

Fig. 3 shows a reticle stocker according to the second embodiment of the present invention. In Fig. 3, reference numeral 31 denotes a load-lock chamber; 32, a reticle stocker; 33, an oxygen analyzer; 34, a nitrogen injection port; 35, an evacuation system; 36, a discharge port; and 37 and 38, on-off valves respectively on the injection and discharge sides. In the second embodiment, the reticle stocker 32 has high airtightness corresponding to vacuum. The oxygen analyzer 33 always monitors the oxygen concentration in the reticle stocker 32. The on-off valve 38 is opened, the interior of the reticle stocker 32 is evacuated, and when the vacuum degree or oxygen concentration reaches a desired value, the on-off valve 38 is closed. After that, the on-off valve 37 is opened to inject nitrogen, and the internal atmosphere is replaced by returning to the atmospheric pressure or a desired pressure. This operation is repeated to rapidly reduce the oxygen concentration in the reticle stocker 32 and maintain the oxygen concentration at 5 ppm or less. After the oxygen concentration reaches a desired value, the reticle stocker 32 is maintained at this oxygen concentration by continuously supplying nitrogen. If the oxygen concentration exceeds a predetermined level owing to any reason such as loading of a reticle, the oxygen concentration is reduced to a desired level again by

atmosphere replacement including evacuation and nitrogen injection.

5 A reticle is loaded into the reticle stocker 32 via the load-lock chamber 31 together with the highly airtight reticle cassette or box or by only itself. The load-lock chamber 31 basically enables loading the reticle into the reticle stocker 32 while preventing an increase in oxygen concentration. In practice, oxygen at ppm level is mixed because it is difficult to remove oxygen left at the reticle itself or the fine structure of the highly airtight reticle cassette or box. The oxygen concentration of the reticle stocker 32 increases at ppm level temporarily or gradually after receiving the reticle. If, however, the oxygen concentration is at an allowable concentration or less, the residual oxygen diffuses with the lapse of time during stocking and is diluted by the flow of nitrogen, thereby reducing the oxygen concentration again. In this case, no atmosphere replacement is done.

20 The highly airtight reticle cassette or box is opened to replace the internal atmosphere by nitrogen in passing through the load-lock chamber 31. To remove the residual oxygen by diffusion, the highly airtight reticle cassette or box is also opened in the reticle stocker 32.

In the use of a reticle, whether the reticle can be used is determined by confirming the oxygen

concentration. A singly stocked reticle is stored and tightly sealed in the highly airtight reticle cassette or box in the reticle stocker 12. A reticle stocked and stored in the highly airtight reticle cassette or box is
5 in an open state and thus is tightly sealed. The tightly sealed reticle is passed through the load-lock chamber 31, and extracted from the reticle stocker 32 while the interior of the highly airtight reticle cassette or box is maintained in a nitrogen atmosphere where the oxygen
10 concentration is low. The highly airtight reticle cassette or box is loaded via the load-lock chamber 31 of the exposure apparatus. Accordingly, the reticle can be used while the atmosphere around the reticle is kept at a low oxygen concentration, and the efficiency and
15 yield of the exposure apparatus can be increased.

[Third Embodiment]

In the third embodiment of the present invention, the reticle stocker 12 of the first embodiment incorporates a reticle changer. The reticle changer can
20 extract a desired reticle in a highly airtight reticle box and can exchange it with a reticle newly entered via the load-lock chamber 11.

[Fourth Embodiment]

Fig. 4 shows a reticle stocker according to the
25 fourth embodiment of the present invention. In the fourth embodiment, the oxygen concentration of the reticle stocker itself is set to a high allowable value

of 50 ppm or less, and the atmospheres of separate highly airtight reticle boxes stocked in the reticle stocker are replaced to manage their oxygen concentrations to 5 ppm or less. Reference numeral 41 denotes a load-lock chamber; 42, a reticle stocker; 43, an oxygen analyzer; 44 and 49, nitrogen injection ports; 45, an evacuation system; 46 and 410, discharge ports; and 47 and 48, on-off valves respectively on the injection and discharge sides. Fig. 4 shows the internal structure by solid lines wherein two highly airtight reticle boxes 411 and 412 are respectively connected to two docks. The respective docks have gas pipes connected to their own nitrogen injection ports and evacuation systems. Nitrogen injection pipes have injection-side on-off valves 413a and 413b, whereas discharge pipes have discharge-side on-off valves 414a and 414b.

The oxygen analyzer 43 measures the oxygen concentration of the main body of the reticle stocker 42. In addition, the oxygen analyzer 43 periodically extracts the internal atmospheres of the highly airtight reticle boxes 411 and 412 connected to their docks and measures the concentrations. On-off valves 415a and 415b are opened in extracting the internal atmospheres of the highly airtight reticle boxes 411 and 412.

The atmosphere of the main body of the reticle stocker 42 is managed similarly to the first embodiment. Nitrogen is injected from the injection port 49, the

discharge port 410 is opened to always generate the flow of nitrogen, and the internal oxygen concentration is kept constant.

Atmosphere replacement of the separate highly
5 airtight reticle boxes 411 and 412 is the same as
atmosphere replacement of the reticle stocker in the
third embodiment. The on-off valves 414a, 414b, and 48
are opened, the interiors of the highly airtight reticle
boxes 411 and 412 are evacuated, and when the vacuum
10 degree or oxygen concentration reaches a desired value,
the on-off valves 414a, 414b, and 48 are closed. Then,
the on-off valves 413a, 413b, and 47 are opened to
inject nitrogen, and the internal atmosphere is replaced
by returning to the atmospheric pressure or a desired
15 pressure. This operation is repeated to rapidly reduce
the oxygen concentration in the highly airtight reticle
boxes 411 and 412. After the oxygen concentration
reaches a desired value, the interiors of the highly
airtight reticle boxes 411 and 412 are maintained at
20 almost the constant low-level oxygen concentration by
continuously supplying nitrogen. If the oxygen
concentration exceeds a predetermined level owing to any
reason such as diffusion of residual oxygen in the
highly airtight reticle boxes 411 and 412, the oxygen
25 concentration is reduced to a desired level again by
atmosphere replacement including evacuation and nitrogen
injection.

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A reticle is loaded into the reticle stocker via the load-lock chamber 41 while stored in the highly airtight reticle box. The load-lock chamber 41 basically enables loading the highly airtight reticle box into the reticle stocker while preventing an increase in oxygen concentration. In practice, oxygen at ppm level is mixed because it is difficult to remove oxygen left at the fine structure of the highly airtight reticle box. The reticle stocker 42 reduces oxygen by diffusion and the flow of nitrogen. The highly airtight reticle box is mounted in the dock inside the reticle stocker and connected to pipes for injection, discharge, and measurement of the oxygen concentration. After connection, the internal oxygen concentration is reduced by performing atmosphere replacement a plurality of number of times.

In the use of a reticle, whether the reticle can be used is determined by confirming the oxygen concentration. The highly airtight reticle box is tightly sealed in dismounting from the dock. The tightly-sealed highly airtight reticle box is passed through the load-lock chamber 41, and extracted from the reticle stocker 42 while the interior of the highly airtight reticle box is maintained in a nitrogen atmosphere where the oxygen concentration is low. The highly airtight reticle box is loaded via the load-lock chamber of the exposure apparatus. The reticle can be

used while the atmosphere around the reticle is kept at a low oxygen concentration, and the efficiency and yield of the exposure apparatus can be increased.

[Fifth Embodiment]

5 In the fifth embodiment of the present invention, a highly airtight reticle cassette for storing one reticle is used instead of the highly airtight reticle box in the fourth embodiment, and connected to a pipe.

[Sixth Embodiment]

10 The sixth embodiment of the present invention uses helium in place of nitrogen in the above embodiments. Alternatively, a gas mixture of nitrogen and helium may be used.

[Seventh Embodiment]

15 The seventh embodiment of the present invention uses inert gas in place of nitrogen in the above embodiments. A general example of inert gas is argon gas, but the inert gas is not limited to this as far as the gas is inert to a process.

20 [Eighth Embodiment]

Fig. 5 shows the eighth embodiment of the present invention. In this embodiment, a reticle stocker is connected to an exposure apparatus using an F₂ excimer laser as an exposure light source via a highly airtight transfer system path shielded from outer air. After the oxygen concentration is reduced in the stocker, a reticle is transferred to the exposure apparatus without

25

being exposed to outer air.

[Ninth Embodiment]

In the ninth embodiment of the present invention,
a wafer is stocked instead of the reticle in the first
5 embodiment.

[10th Embodiment]

In the 10th embodiment of the present invention, a
wafer is stocked instead of the reticle in the third
embodiment.

10 [11th Embodiment]

In the 11th embodiment of the present invention, a
wafer is stocked instead of the reticle in the sixth
embodiment.

[12th Embodiment]

15 Fig. 2 shows the 12th embodiment of the present
invention. In this embodiment, a wafer stocker is
arranged on a semiconductor manufacturing line. The
wafer stocker is connected to an exposure apparatus
using an F₂ excimer laser as an exposure light source via
20 a highly airtight transfer system path shielded from
outer air. After the oxygen concentration is reduced in
the stocker, a wafer is transferred to the exposure
apparatus without being exposed to outer air.

[Embodiment of Semiconductor Production System]

25 A production system for a semiconductor device
(semiconductor chip such as an IC or LSI, liquid crystal
panel, CCD, thin-film magnetic head, micromachine, or

the like) will be exemplified. A trouble remedy or periodic maintenance of a manufacturing apparatus installed in a semiconductor manufacturing factory, or maintenance service such as software distribution is performed by using a computer network outside the manufacturing factory.

Fig. 6 shows the overall system cut out at a given angle. In Fig. 6, reference numeral 101 denotes a business office of a vendor (apparatus supply manufacturer) which provides a semiconductor device manufacturing apparatus. Assumed examples of the manufacturing apparatus are semiconductor manufacturing apparatuses for various processes used in a semiconductor manufacturing factory, such as pre-process apparatuses (lithography apparatus including an exposure apparatus, resist processing apparatus, and etching apparatus, annealing apparatus, film formation apparatus, planarization apparatus, and the like) and post-process apparatuses (assembly apparatus, inspection apparatus, and the like). The business office 101 comprises a host management system 108 for providing a maintenance database for the manufacturing apparatus, a plurality of operation terminal computers 110, and a LAN (Local Area Network) 109 which connects the host management system 108 and computers 110 to construct an intranet. The host management system 108 has a gateway for connecting the LAN 109 to Internet 105 as an external network of the

business office, and a security function for limiting external accesses.

Reference numerals 102 to 104 denote manufacturing factories of the semiconductor manufacturer as users of manufacturing apparatuses. The manufacturing factories 102 to 104 may belong to different manufacturers or the same manufacturer (pre-process factory, post-process factory, and the like). Each of the factories 102 to 104 is equipped with a plurality of manufacturing apparatuses 106, a LAN (Local Area Network) 111 which connects these apparatuses 106 to construct an intranet, and a host management system 107 serving as a monitoring apparatus for monitoring the operation status of each manufacturing apparatus 106. The host management system 107 in each of the factories 102 to 104 has a gateway for connecting the LAN 111 in the factory to the Internet 105 as an external network of the factory. Each factory can access the host management system 108 of the vendor 101 from the LAN 111 via the Internet 105. The security function of the host management system 108 authorizes access of only a limited user. In this system, the factory notifies the vendor via the Internet 105 of status information (e.g., the symptom of a manufacturing apparatus in trouble) representing the operation status of each manufacturing apparatus 106. The vendor can transmit, to the factory, response information (e.g., information designating a remedy against the trouble, or

remedy software or data) corresponding to the notification, or maintenance information such as the latest software or help information. Data communication between the factories 102 to 104 and the vender 101 and data communication via the LAN 111 in each factory typically adopt a communication protocol (TCP/IP) generally used in the Internet. Instead of using the Internet as an external network of the factory, a dedicated-line network (e.g., ISDN) having high security which inhibits access of a third party can be adopted. It may also be possible that the user constructs a database in addition to one provided by the vendor and sets the database on an external network and that the host management system authorizes access to the database from a plurality of user factories.

Fig. 7 is a view showing the concept of the overall system of this embodiment that is cut out from a different aspect from Fig. 6. In the above example, a plurality of user factories having manufacturing apparatuses and the management system of the manufacturing apparatus vendor are connected via an external network, and production management of each factory or information of at least one manufacturing apparatus is communicated via the external network. In the example of Fig. 7, a factory having manufacturing apparatuses of a plurality of vendors, and the management systems of the vendors for these

manufacturing apparatuses are connected via the external network of the factory, and maintenance information of each manufacturing apparatus is communicated. In Fig. 7, reference numeral 201 denotes a manufacturing factory of a manufacturing apparatus user (semiconductor device manufacturer) where manufacturing apparatuses for various processes, e.g., an exposure apparatus 202, resist processing apparatus 203, and film formation apparatus 204 are installed in the manufacturing line of the factory. Fig. 7 shows only one manufacturing factory 201, but a plurality of factories are networked in practice. The respective apparatuses in the factory are connected to a LAN 206 to construct an intranet, and a host management system 205 manages the operation of the manufacturing line. The business offices of vendors (apparatus supply manufacturers) such as an exposure apparatus manufacturer 210, resist processing apparatus manufacturer 220, and film formation apparatus manufacturer 230 comprise host management systems 211, 221, and 231 for executing remote maintenance for the supplied apparatuses. Each host management system has a maintenance database and a gateway for an external network, as described above. The host management system 205 for managing the apparatuses in the manufacturing factory of the user, and the management systems 211, 221, and 231 of the vendors for the respective apparatuses are connected via the Internet or dedicated-line network

serving as an external network 200. If a trouble occurs in any one of a series of manufacturing apparatuses along the manufacturing line in this system, the operation of the manufacturing line stops. This trouble can be quickly solved by remote maintenance from the vendor of the apparatus in trouble via the Internet 200. This can minimize the stop of the manufacturing line.

Each manufacturing apparatus in the semiconductor manufacturing factory comprises a display, a network interface, and a computer for executing network access software and apparatus operating software which are stored in a storage device. The storage device is a built-in memory, hard disk, or network file server. The network access software includes a dedicated or general-purpose web browser, and provides a user interface having a window as shown in Fig. 8 on the display. While referring to this window, the operator who manages manufacturing apparatuses in each factory inputs, in input items on the windows, pieces of information such as the type of manufacturing apparatus (401), serial number (402), subject of trouble (403), occurrence date (404), degree of urgency (405), symptom (406), remedy (407), and progress (408). The pieces of input information are transmitted to the maintenance database via the Internet, and appropriate maintenance information is sent back from the maintenance database and displayed on the display. The user interface

provided by the web browser realizes hyperlink functions
(416 to 418), as shown in Fig. 8. This allows the
operator to access detailed information of each item,
receive the latest-version software to be used for a
5 manufacturing apparatus from a software library provided
by a vendor, and receive an operation guide (help
information) as a reference for the operator in the
factory.

A semiconductor device manufacturing process using
10 the above-described production system will be explained.
Fig. 9 shows the flow of the whole manufacturing process
of the semiconductor device. In step 1 (circuit design),
a semiconductor device circuit is designed. In step 2
(mask formation), a mask having a designed circuit
15 pattern is formed. In step 3 (wafer manufacture), a
wafer is manufactured using a material such as silicon.
In step 4 (wafer process) called a pre-process, an
actual circuit is formed on the wafer by lithography
using a prepared mask and the wafer. Step 5 (assembly)
20 called a post-process is the step of forming a
semiconductor chip by using the wafer manufactured in
step 4, and includes an assembly process (dicing and
bonding) and packaging process (chip encapsulation). In
step 6 (inspection), inspections such as the operation
25 confirmation test and durability test of the
semiconductor device manufactured in step 5 are
conducted. After these steps, the semiconductor device

is completed and shipped (step 7). The pre-process and post-process are performed in separate dedicated factories, and maintenance is done for each of the factories by the above-described remote maintenance system. Information for production management and apparatus maintenance is communicated between the pre-process factory and the post-process factory via the Internet or dedicated-line network.

Fig. 10 shows the detailed flow of the wafer process. In step 11 (oxidation), the wafer surface is oxidized. In step 12 (CVD), an insulating film is formed on the wafer surface. In step 13 (electrode formation), an electrode is formed on the wafer by vapor deposition. In step 14 (ion implantation), ions are implanted in the wafer. In step 15 (resist processing), a photosensitive agent is applied to the wafer. In step 16 (exposure), the above-mentioned exposure apparatus bakes and exposes the circuit pattern of a mask on the wafer. In step 17 (developing), the exposed wafer is developed. In step 18 (etching), the resist is etched except for the developed resist image. In step 19 (resist removal), an unnecessary resist after etching is removed. These steps are repeated to form multiple circuit patterns on the wafer. A manufacturing apparatus used in each step undergoes maintenance by the remote maintenance system, which prevents a trouble in advance. Even if a trouble occurs, the manufacturing apparatus can be quickly

recovered. The productivity of the semiconductor device can be increased in comparison with the prior art.

As has been described above, according to the present invention, the oxygen concentration or moisture concentration in a stocker can be quickly reduced, and a reticle, wafer, or the like can be transported to an exposure apparatus after the concentration is satisfactorily reduced. The oxygen concentration or moisture concentration around the reticle or wafer in exposure can be rapidly reduced to 1 ppm or less and easily managed. This can increase the efficiency and yield of the exposure apparatus using an F₂ excimer laser as a light source.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.